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A METHOD OF ESTIMATING THE PERCENTAGE OF INFECTION OF APPLE LEAVES BY RUST WITH OBSERVATIONS ON THE RELATIVE SUSCEPTIBILITY OF SPECIES AND VARIETIES OF MALUS AND JUNIPERUS

Paul R. Miller (Oct. 1)

To be of maximum value to pathologists the plant disease loss estimates made from year to year and recorded in the Plant Disease Survey Office must be of a comparative nature. For example, if the methods of taking notes on the prevalence of apple rust and the terms denoting the relative susceptibility of apples to rust lack uniformity, discrepancies enter into the records, with resultant confusion concerning varietal susceptibility to the various species of Gymnosporangium. Although the relative susceptibility is probably of a qualitative nature, depending upon the host, the parasite, and the atmospheric conditions, the extent of loss from the disease due to the destruction of leaf tissue is apparently a quantitative value which can be measured from the prevalence and size of lesions per unit area. Reed and Crabill (2) have shown by careful experiments that apple leaves infected with rust cannot regulate transpiration, that respiration is greatly increased, and that photosynthesis is considerably impaired.

As an aid to uniformity in measuring the amount of rust infection on apple foliage, a modification of the methods used by Bliss (1) and by Tehon and Stout (3) has been adopted for this study.

The purpose of this report, therefore, is three-fold: (1) to record some authentic information on varietal susceptibility of apples to rust under Tennessee conditions; (2) to present some data on the amount of apple rust in relation to the distance of the apple trees from cedars; and (3) to emphasize the need for standardizing the methods of obtaining and recording estimates of both plant disease infection and plant disease loss, calling attention to the value in survey work of differentiating between those diseases which cause complete loss and those which merely injure the plant or mar the product.

Fig. 8. Chart used in approximating percentage of leaf area infected with apple rust.

The chart illustrated in Fig. 8 was devised as an aid to standardization and employed in the field studies here reported. It was prepared by tracing the margin of an average-size Rome leaf on cross section coordinate graph paper. The number of squares covered by the leaf was 400. An area of the approximate size and shape of typical lesions on leaves of Rome traced on the chart covered the equivalent of four squares or one per cent of the surface. This area was covered with ink to obtain the first figure of the chart. The process was continued until the leaf had been traced six times and the squares filled in to obtain scale classes equal to 1, 3, 10, 15, 25, and 65 per cent. This chart was photographed natural size on heavy paper so that it could be handled easily in the orchard. In the field work it was, therefore, unnecessary for the mind to transpose the picture size of the leaf to the actual size in order to estimate the area infected. Although apple leaves vary in size, and likewise the judgment of the observer is subject to error in classifying each leaf, the method was found to be fairly accurate as was proved by measuring the lesions and areas of 100 leaves of a given sample. In this case the actual value deviated from the estimated value only .02 per cent.

The procedure in the orchard was as follows: A tree of a known variety was chosen and a limb selected at random; then the leaves of the limb were matched with those of the photograph and the data recorded as shown in the chart below:

Scale classes	0	1	3	10	15	25	65	Total
Class frequency	225	30	9	7	4	6	4	285
Class values	0	30	27	70	60	150	260	597

Of the 285 leaves examined, 225 were not infected, 30 leaves fell in the 1 per cent class, 9 in the 3 per cent class, etc. For determining the average amount of infection shown by these observations a series of items labeled in the chart as "Class values" was computed by multiplying the percentage value of each of these classes by the frequency of each class respectively as represented. The 225 leaves in the "0" class have a class value, or infection value, of 0; those in the "1" class have a class value of 30, etc. The sum of all the class values is 597. This quantity, which is the summation of the total percentage area of rust infected leaf surface shown by the entire leaf sample, was divided by 287, the number of leaves in the sample, to obtain the average percentage of rust-infected area per leaf. The result in this case was 2.09. This figure is representative not only of the leaves examined but also of the average condition of all the leaves of this variety under these conditions, provided those selected at random and examined constituted a representative sample.

By using this method of estimating percentage infection, results were obtained for the principal varieties of apples grown in Tennessee as shown in Table 9.

Table 9. Percentage of rust infection and relative susceptibility of certain varieties of apples.

Variety	Percentage of rusted leaves	Percentage of total leaf area infected	Percentage of rusted fruit	Susceptibility*
Rome	65.2	4.27	7.	VS
Golden Delicious	57.7	2.43	0	S
Wealthy	68.9	5.67	4.5	VS
Jonathan	32.6	2.31	2.8	S
Yellow Transparent	27.4	.57	0.	R
Ben Davis	13.2	.46	6.	R
York Imperial	10.	1.04	3.2	S
Stayman	14.3	.09	0	VR
Winesap	8.	.006	2.(Quince rust)	VR
Grimes Golden	15.4	.29	0	R
King David	4.	.001	0	VR
Winter Banana	27.4	2.16	0.5	S
Horse	15.6	1.43	0	S
Paragon	0	0	0	VR
Kinnaird	0	0	0	VR

*VS equals Very susceptible
S equals Susceptible
R equals Resistant
VR equals Very resistant

The amount of infection was determined on each of two varieties of apples growing under different conditions of infection as determined (1) by the abundance of cedars and (2) by their distance from the apples. The results are found in the following Table 10.

Table 10. Percentage of rust infection on leaves of Rome and Golden Delicious apples in relation to abundance of cedars and their distance from the orchards.

Variety	Cedars abundant within 1/2 mile of orchard		Two cedars within 1/2 mile of orchard		Cedars abundant 2 miles from orchard	
	% of leaves infected	% of total leaf area infected	% of leaves infected	% total leaf area infected	% of leaves infected	% total leaf area infected
Rome	85	5.26	24	1.87	17	.71
Golden Delicious	72	3.03	33	1.07	22	.045

Quince rust, Gymnosporangium germinale, was found on Red Delicious, Winesap, and in traces on Rome in the following ten counties: Roane, Cumberland, Warren, Anderson, Henry, Putnam, Madison, Savier, Jefferson, and Knox. It has been reported previously from the four counties last named.

A private arboretum in Knox County containing numerous species of Malus and Juniperus growing in close proximity afforded an excellent opportunity to obtain information on the species susceptibility of these two hosts to Gymnosporangium juniperi-virginianae. In these plantings spore-horn emergence and sporulation took place May 5, 10, 16, 22, and 29, 1934, with the following amounts of rainfall recorded in inches: .57, .85, 1.34, .77, and .40 respectively. The results of this study are shown in Tables 11 and 12.

Table 11. Infection of Malus spp. by Gymnosporangium juniperi-virginianae, as observed in Knox County, Tennessee.

Host	% leaf area infected	Host	% leaf area infected
Malus angustifolia	4.72	Malus ioensis plena	4.95
M. pulcherrima		M. lancifolia	2.42
arnoldiana	.02	M. sargenti	.143
M. baccata	.643	M. adstringens	0
M. bracteata	1.05	M. atropurpurea	0
M. coronaria	2.16	M. prunifolia	.002
M. coronaria charlottae	3.27	M. prunifolia rinki	.001
M. coronaria elongata	2.107	M. pumila	0
M. dawsoniana	1.23	M. pumila pendula	.003
M. floribunda	2.45	M. robusta	.014
M. fusca	.046	M. sieboldii	0
M. glabrata	1.71	M. sieboldii abore-	
M. glaucescens	1.53	scens	0
M. ioensis	2.37	M. spectabilis	.007
M. ioensis bechteli	5.31	M. tschonoski	0
M. ioensis palmeri	4.28	M. zumi	0

Table 12. Relative susceptibility of Juniperus spp. and varieties to Gymnosporangium juniperi-virginianae, as observed in Knox County, Tennessee.

Host	Susceptibility*
Juniperus virginiana	S
J. virginiana albo-spica	R
J. virginiana burki	R
J. virginiana canaertii	VS
J. virginiana elegantissima	VS
J. virginiana glauca	S
J. virginiana globosa	S
J. virginiana keteleeri	R
J. virginiana kosteri	R
J. virginiana pendula	S
J. virginiana pyramidalis	S
J. virginiana pyramidiformis	R
J. virginiana schotti	S
J. virginiana smithii	R
J. virginiana triparttia	R
J. virginiana venusta	S
Juniperus horizontalis	S
Juniperus chinensis and 10 varieties	R
Juniperus communis and 18 varieties	R
Juniperus sabina and 6 varieties	R
Juniperus squamata and 3 varieties	R

* S, VS, R, as in Table 9.

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WEATHER AND DISEASE IN MASSACHUSETTS

Reported by O. C. Boyd (Oct. 4)

Weather conditions proved very favorable for diseases of most crops that were growing in September. There were very few clear days, and rains fell on over half the days of that month. Late infection of apple scab (Venturia inaequalis) on McIntosh is now showing up in storage. Vegetable

diseases that flourished during the wet month were: squash black rot (Mycosphaerella citrullina); celery early blight (Cercospora apii) and late blight (Septoria spp.); potato and tomato late blights (Phytophthora infestans); anthracnose and downy mildew (Colletotrichum lagenarium and Pseudoperonospora cubensis) of cucumbers, muskmelons, and watermelons; damping-off (various organisms) and downy mildew (Peronospora effusa) of spinach, the latter disease, however, being rather spotted or scattered in its distribution; anthracnose (Colletotrichum lindemuthianum) on late bean plantings; leaf blights (Macrosporium carotae and Cercospora apii carotae) of carrots; leaf blight of parsnips (Ramularia pastinacae); bottom rot and drop (Corticium vagum and Sclerotinia libertiana) of lettuce; black rot of turnips and cauliflower (Bacterium campestre), the former undergoing losses from light to 75 per cent in places.

The Cercospora leaf blight of carrots and the leaf blight of parsnips have been more damaging the State over than in any previous year under observation. Cercospora is decidedly more prevalent than Macrosporium on carrots. Very little dusting or spraying is practiced on those crops.

Late blight of tomatoes was first reported about September 3 or 4 in Bristol County; on September 7 in Plymouth County; on September 8, as early stages of infection in a demonstration at the college in which there was definite evidence of seed-transmission of the disease; and not until about September 20 in other gardens and fields in the Connecticut Valley. Only widely scattered infections were seen late in September in Middlesex, Essex, and Worcester Counties where the disease was epidemic and destructive in late August and early September last year. Total losses from this disease are small indeed compared with those in 1933, due primarily to its very scattered distribution and lateness of development. The delay in appearance was attributed to the generally dry, warm weather throughout August; and the scattered or almost local distribution, to the apparently limited overwintering of the fungus in the State during the severe winter as compared with its possibly general survival in the preceding winter.

Growers who dusted or sprayed tomatoes in August and September according to recommendations not only experienced no loss from late blight, but held their foliage well against early blight (Alternaria solani) infection. Those who failed to protect their fields suffered heavy defoliation generally from early blight throughout August and September.

There was very little late blight of potatoes until the onset of rains in September. In fields where the vines died or matured before September, there is very little tuber rot. In fields where vines were kept green until September by spraying in August, but where no applications were made in September, there is at present plenty of late blight rot. The best growers of late potatoes, however, who kept the vines thoroughly protected into September, as long as the vines were green and growing, are now digging out only a trace of tuber rot, and have generally the highest yields.

Although scab (Cladosporium cucumerinum) and black rot (Mycosphaerella) were less conspicuous on winter squash vines this summer than usual, due apparently to the dry weather of July and August, yet Mycosphaerella developed rapidly in many fields after the September rains set in, and will no doubt cause appreciable loss of fruits in storage unless the crops are disinfected properly before storing.

Damage from apple scab this fall is somewhat less general than in the average season. Where sprays were properly timed and applied thoroughly during spring and early summer, growers have found the disease easy to control this year. Where it was not checked satisfactorily, considerable late infection was present on McIntosh at harvest and additional infection is appearing in storage.

WEATHER AS A FACTOR CONTRIBUTING TO SOME UNUSUAL PLANT DISEASE LOSSES IN TENNESSEE - 1934

Paul R. Miller

Several plant diseases caused considerably more damage in Tennessee this year than in normal years. Certain unusual weather conditions probably were the chief contributing factor.

Bitter rot (Glomerella cingulata) was very severe on apples in eastern Tennessee. Counts in various orchards near Knoxville showed about 20 per cent loss, on the average, with the loss to Golden Delicious in one orchard amounting to about 50 per cent. Knoxville's August rainfall was 3.59 inches above normal. Some rain fell each day, with the exception of two, from August seventh to twenty-fifth, inclusive. The mean monthly temperature was also 2.2 degrees above normal.

In southwestern Tennessee angular leaf spot (Bacterium malvacearum) on cotton was much more severe than it has been observed to be for 15 years. In Jackson, rains occurred each day from June fifth to twenty-fifth, inclusive, with the exception of the seventh, followed on the eighteenth by 3.94 inches of rainfall accompanied by strong winds. (P.D.R. Vol. 18, No. 8, p. 111).

Near Jackson growth cracking caused unusual damage to Stayman apples. Approximately 25 per cent of the fruits in one ten-acre block of Staymans were cracked. The last half of July and the month of August were exceptionally dry, followed by heavy rains the first of September.

In northwestern Tennessee the growing season for sweet potatoes was exceptionally dry. Stem rot (Fusarium batatatis) was very severe, while black rot (Ceratostomella fimbriata) was negligible. (P.D.R. Vol. 18, No. 8, p. 110).

OTHER OBSERVATIONS ON DISEASES IN TENNESSEE: Sooty blotch and fly speck (Gloeodes pomigena and Leptothyrium pomi) on apple and pear have been unusually prevalent and abundant in eastern Tennessee this year.

Frog-eye leaf spot of tobacco (Cercospora nicotianae) was extremely severe in eastern Tennessee, and it seemed to make its appearance later in the growing season than it has in normal years.

Sclerotium rolfsii was observed on 10 per cent of the plants of a ten-acre peanut field near Athens.

Cotton anthracnose (Glomerella gossypii) was found on approximately 10 per cent of the bolls in a ten-acre field near Sweetwater.

ANTHRACNOSE OF COTTON IN SOUTH CAROLINA

As reported earlier heavy losses of young cotton seedlings occurred in May, 1934, in certain portions of South Carolina. This was the first instance of heavy losses since 1929. A Colletotrichum was present in most of these seedlings. Inoculations have shown that this fungus will produce lesions on cotton bolls typical of those due to anthracnose (Glomerella gossypii).

In early September a survey was made of the fields in which seedling losses occurred. In all such fields light to severe boll-rot due to anthracnose was found. Anthracnose boll-rot is generally distributed throughout the State. In most sections the damage is very small. In several sections heavily infected fields have been found. Orangeburg and Jasper Counties each contain a heavily infected area of undetermined extent. The severe losses in Orangeburg County were largely limited to plantings of the Half-and-Half variety. (C. H. Arndt, Oct. 10).

DUTCH ELM DISEASE IN INDIANA

R. Kent Beattie

The Dutch elm disease has been found in Indianapolis, Indiana. Specimens taken from four different Indianapolis elm trees when cultured at the Dutch elm disease laboratory at Morristown, New Jersey, proved to be affected with this serious disease. All these trees are near a veneer factory which has in the past imported elm logs from Europe for the cutting of fancy veneer.

A few days ago, Walter H. Banfield and Paul V. Mook, technicians of the Civilian Conservation Corps attached to the Division of Forest Pathology of the Bureau of Plant Industry, passed through Indianapolis while visiting camps and instructing the personnel in regard to this elm disease. They searched the elms in the vicinity and sent in the specimens herein mentioned.

The diseased trees have been destroyed by the Indiana State Officials. (Oct. 17).

PRESENT STATUS OF THE DUTCH ELM DISEASE

The total number of trees affected by the Dutch elm disease, as determined by the growth of Graphium ulmi in culture, was 7,432 on October 10. This includes all infected trees found since the discovery of the disease in this country. Of these diseased trees 4,940 were located in New Jersey; 2,420 in New York; 56 in Connecticut; 11 in Ohio; 4 in Indiana (reported by Mr. Beattie in this issue of the Reporter); and 1 in Maryland.

Infected trees in New York and Connecticut are being destroyed promptly on discovery but the eradication program in New Jersey is hampered by lack of available funds.